

Sensory evaluation of Florentine bar cookie formulation with the addition of roselle (*Hibiscus sabdariffa* L.) powder

[Evaluasi sensori Florentine bar cookies dengan penambahan bubuk rosela (*Hibiscus sabdariffa* L.)]

Esteria Priyanti*, Inggritia Maestra Citra Dewi, Arina Nur Alvina

Culinary Arts Study Program, Ibu Kartini Academy of Social Welfare, Sultan Agung Street, Semarang City, Central Java, Indonesia

*Corresponding author email: esteria@aksibukartini.ac.id

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ABSTRACT

Conventional round Florentine cookies are fragile and lack functional ingredients, limiting their market potential. Reformulating them into bars improves consumption practicality, while adding roselle (*Hibiscus sabdariffa* L.) powder enhances natural color and bioactive value. However, research on roselle's application in Florentine bar cookies remains limited. This study aimed to analyze the effect of adding roselle calyx powder (*Hibiscus sabdariffa* L.) on the sensory characteristics and nutritional content of Florentine bar cookies. The study employed a Completely Randomized Design (CRD) with three roselle powder concentration treatments, namely R1 (1.64% w/w), R2 (4.10% w/w), and R3 (6.56% w/w) based on 120 g of Florentine flour. Sensory evaluation was conducted by 25 semi-trained panelists using a five-point hedonic test, while nutritional content analysis was performed on the selected sample using the SNI 01-2891-1992 method. The Kruskal–Wallis test results showed that the addition of roselle powder had a significant effect on taste ($p < 0.05$) and texture ($p < 0.05$), but no significant effect on aroma ($p > 0.05$) and color ($p > 0.05$). Formulation R1 achieved the highest acceptance, with taste score 4.48 ± 0.81 , aroma score 4.00 ± 0.80 , texture score, 4.04 ± 0.82 , and color scores 4.04 ± 0.77 . Nutritional analysis indicated that Florentine bar cookies per serving (26 g) provide 132.6 kcal of energy (6% RDA), 7.29 g of fat (11% RDA), 2.69 g of protein (4% RDA), and 13.87 g of carbohydrates (4% RDA). Formulation R1 represents the optimal concentration, producing a product with the best balance between functional value and sensory acceptability, and therefore holds potential to be developed as an innovative bakery product based on local ingredients.

Keywords: Florentine bar cookies, roselle, hedonic test, nutritional content, functional product

ABSTRAK

Kukis Florentine konvensional berbentuk bundar kerap memiliki kelemahan pada struktur yang rapuh serta minimnya diversifikasi bahan lokal fungsional, sehingga membatasi potensinya di pasar camilan modern. Diversifikasi menjadi bentuk bar dapat meningkatkan kepraktisan konsumsi, sedangkan penambahan bubuk rosella (*Hibiscus sabdariffa* L.) memberikan warna alami yang menarik serta meningkatkan potensi senyawa bioaktif. Meskipun pemanfaatan rosella terus berkembang, penelitian komprehensif mengenai aplikasinya pada Florentine bar cookies masih terbatas. Penelitian ini bertujuan untuk menganalisis pengaruh penambahan bubuk kelopak bunga rosella (*Hibiscus sabdariffa* L.) terhadap karakteristik sensoris dan kandungan gizi Florentine bar cookies. Penelitian menggunakan Rancangan Acak Lengkap (RAL) dengan tiga perlakuan konsentrasi bubuk rosella, yaitu R1 (1,64% w/w), R2 (4,10% w/w), and R3 (6,56% w/w) per 120 g tepung florenta. Evaluasi sensoris dilakukan oleh 25 panelis semi terlatih menggunakan uji hedonik dengan skala lima poin, sedangkan analisis kandungan gizi dilakukan pada sampel terpilih menggunakan metode SNI 01-2891-1992. Hasil uji Kruskal-Wallis menunjukkan bahwa penambahan bubuk rosella berpengaruh signifikan terhadap rasa ($p < 0.05$) dan tekstur ($p < 0.05$), namun tidak berpengaruh nyata terhadap aroma ($p > 0,05$) dan warna ($p > 0,05$). Formulasi R1 memperoleh penerimaan tertinggi dengan skor rasa $4,48 \pm 0,81$, aroma $4,00 \pm 0,80$, tekstur $4,04 \pm 0,82$, dan warna $4,04 \pm 0,77$. Analisis kandungan gizi menunjukkan bahwa Florentine bar cookies per sajian (26 g) menyediakan energi 132,6 kkal (6% AKG), lemak 7,29 g (11% AKG), protein 2,69 g (4% AKG), dan karbohidrat 13,87 g (4% AKG). Formulasi R1 merupakan konsentrasi optimal yang menghasilkan produk dengan keseimbangan terbaik antara nilai fungsional dan akseptabilitas sensoris, sehingga berpotensi dikembangkan sebagai produk bakery inovatif berbasis bahan lokal.

Kata kunci: Florentine bar cookies, rosella, uji hedonik, kandungan gizi, produk fungsional

Introduction

Florentine cookies are a premium European-style cookie product characterized by a distinctive combination of caramel, butter, nuts (particularly almonds), and dried fruits, baked to produce a crisp texture. Conventionally, Florentine cookies are produced in a flat, round shape, following a tradition that has been maintained for decades. The production process of Florentine cookies is relatively simple, involving the mixing of all ingredients, shaping and flattening the dough, and then baking it. When baked using appropriate techniques, this combination of ingredients results in a product with a characteristic crispness and a unique flavor profile.

Recent cookie formulations enriched with nuts, seeds, and dried fruits have gained attention for their sensory and functional benefits, including increased fiber, mineral content, and antioxidant activity (Schouten et al., 2024). However, innovation in Florentine cookies remains limited, particularly in product-form diversification and the use of local functional ingredients (Putri et al., 2024). Conventional Florentine cookies are typically round, which can be fragile and less convenient for portable consumption (Putri et al., 2024). Transforming them into bar-shaped cookies may improve handling and portability while expanding their market potential to consumers seeking practical snacks (Sethi et al., 2016; Izzo et al., 2023). Another limitation is the limited incorporation of local functional ingredients. Unlike traditional European formulations based on wheat flour, butter, almonds, and dried fruits (Violet & Suryoprabowo, 2025), Indonesian food diversity offers numerous underutilized ingredients with functional potential (Putri et al., 2024). Roselle calyces (*Hibiscus sabdariffa* L.) are particularly promising due to their long-standing culinary and medicinal use, yet their application in premium pastry products remains limited (Mahunu et al., 2021).

In the context of recent developments, cookie formulations enriched with nuts, seeds, and dried fruits have attracted considerable attention. The addition of these ingredients is not merely intended to enhance sensory qualities, but also to provide functional value by increasing fiber and mineral content as well as antioxidant activity (Schouten et al., 2024). Nevertheless, the development of Florentine cookies using innovative approaches remains notably limited, particularly in two crucial aspects: diversification of product forms and the utilization of local food ingredients with high functional value (Putri et al., 2024).

The first aspect of this limitation relates to the shape of Florentine cookies. In general, Florentine cookies are produced in a round form. Although the round shape has a classical aesthetic value and is widely recognized by consumers, it presents several limitations from a functional perspective. Round Florentine cookies tend to be fragile and less practical, which restricts their market segmentation mainly to formal consumption settings or home use (Putri et al., 2024). Transforming conventional round Florentine cookies into Florentine bar cookies can improve consumption practicality and broaden market segmentation. The bar form creates opportunities to reach consumers such as office workers who need practical snacks at work, students seeking nutritious snacks to take to school, athletes requiring a quick energy source in a portable format, and travelers who prefer snacks that are not easily broken during journeys (Sethi et al., 2016). Thus, shape diversification not only expands the potential consumer base but also positions the product to compete in the rapidly growing snack bar category (Izzo et al., 2023).

The second aspect of the limitation in Florentine cookie development lies in the minimal exploration of local ingredients with functional value. Traditional European recipes use ingredients commonly available in that region, such as wheat flour, butter, almonds, and dried fruits like cherries or orange peel (Violet & Suryoprabowo, 2025). However, in Indonesia, with its rich tropical biodiversity, there exists a reservoir of local ingredients with remarkable potential that has not yet been optimally utilized in modern pastry products (Putri et al., 2024). One promising local ingredient is roselle calyces (*Hibiscus sabdariffa* L.), a plant long known in Indonesian culinary and medicinal traditions (Almajid et al., 2023), yet whose application in premium pastry products remains very limited (Mahunu et al., 2021).

The use of plant-based natural colorants in food products is increasing with consumer demand for clean-label foods. Roselle (*Hibiscus sabdariffa* L.) is a promising ingredient because its anthocyanin pigments, particularly pelargonidin, provide an attractive natural red color while contributing functional value (Mardiah et al., 2021). Recent studies have demonstrated the potential of roselle to improve the sensory and nutritional properties of various food products. Roselle incorporation enhanced consumer acceptance and shelf life of muffins (Marak et al., 2022), while 5% roselle calyx powder produced the highest sensory acceptance in biscuits (Hernández-Nava et al., 2023). In bread, 4–8% roselle flour increased color intensity and total phenolic and anthocyanin contents (Qin et al., 2024). Similarly, 30% roselle calyx extract achieved the highest sensory scores in jelly candy (Sitohang, 2026). These findings highlight roselle as a promising natural colorant and functional ingredient for food product development.

Notwithstanding these advancements, existing studies remain predominantly confined to discrete product categories such as muffins, biscuits, bread, and jelly candy (Marak et al., 2022; Halim et al., 2022). Consequently, a substantial research gap persists regarding the application of roselle in snack bar products, particularly Florentine bar cookies. Furthermore, no comprehensive investigation has simultaneously evaluated the effects of roselle incorporation on both the sensory characteristics and nutritional composition of this specific food matrix. To address this gap, this study aimed to investigate the effects of roselle powder addition on the sensory and nutritional properties of Florentine bar cookies, thereby contributing to the broader scientific discourse on roselle-based functional food development.

Materials and method

Materials and equipment

The main ingredients used in this study included Florentine flour, roselle powder (*Hibiscus sabdariffa* L.), sunflower seeds, pumpkin seeds, cashew nuts, almonds, raisins, dried cranberries, and sesame seeds. All ingredients were purchased from a certified local food supplier and were food-grade quality. The equipment used consisted of a Kirin KBO-190 electric oven (Kirin Enterprises Co., Ltd., Indonesia), a Taffware Digipounds digital balance (Model i2000, Taffware, Indonesia; precision 0.1 g), a cutting board, stainless steel knives, stainless steel mixing bowls, stainless steel spatulas, aluminium baking trays, and stainless-steel snack bar molds measuring 8 x 4 x 3 cm.

Research methods

The study used a Completely Randomized Design (CRD) with one treatment factor, namely the concentration of roselle calyx powder relative to the weight of Florentine flour (120 g). The treatments tested were R1 with the addition of 2 g roselle powder (1.64% w/w), R2 with 5 g roselle powder (4.10% w/w) and R3 with 8 g roselle powder (6.56% w/w). Each treatment was replicated three times, resulting in nine experimental units. The complete formulation is presented in Table 1.

Table 1. Formulation of Florentine bar cookies for each treatment

Ingredients	Amount		
	R1 (g)	R2 (g)	R3 (g)
Florentine flour	120	120	120
Roselle powder	2	5	8
Sunflower seeds	25	25	25
Pumpkin seeds	25	25	25
Cashew nuts (sliced)	25	25	25
Almonds (sliced)	25	25	25
Raisins (sliced)	25	25	25
Dried cranberries (sliced)	25	25	25
Sesame seeds	10	10	10

Research procedures

Sunflower seeds, pumpkin seeds, cashew nuts, and almonds were roasted in an oven at 150°C for 15 minutes with periodic stirring at 5-minute intervals to ensure even roasting. After roasting, the ingredients were cooled to room temperature ($\pm 30^\circ\text{C}$) for 15 minutes on a wire cooling rack before further processing. The preparation of Florentine bar cookies was then carried out according to the following procedure:

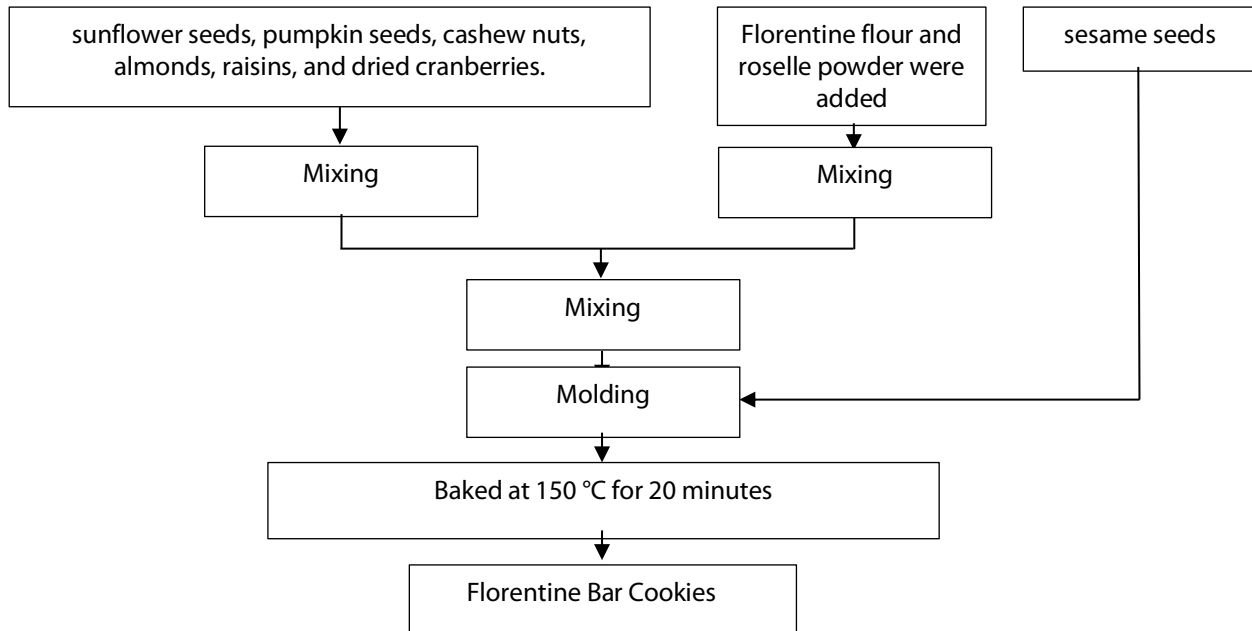


Figure 1. Flow diagram of Florentine bar cookies production with the addition of roselle powder

The preparation procedure was as follows: (1) Dry ingredients (sunflower seeds, pumpkin seeds, cashew nuts, almonds, raisins, and dried cranberries) were weighed and combined in a 2 L stainless steel mixing bowl and stirred manually with a spatula for 1 minute to achieve homogeneous distribution. (2) Florentine flour and the corresponding weight of roselle calyx powder were added to the dry ingredient mixture. The combined ingredients were stirred continuously for 2 minutes until uniformly incorporated. (3) Sesame seeds were added and folded into the mixture for a further 30 seconds. (4) The mixture was transferred into the stainless-steel bar moulds (8 x 4 x 3 cm). Each mould was filled to approximately 80% capacity and the surface was pressed firmly and evenly with a flat spatula to achieve a compact, uniform bar shape with a target thickness of 2.5 ± 0.2 cm. (5) Filled moulds were placed on a flat aluminium baking tray and baked in the Kirin KBO-190 oven at 150°C for 20 minutes. (6) Finished bars were cooled in the moulds for 10 minutes then demoulded and allowed to cool completely on a wire rack.

Research parameters

This study employed an experimental method using a single-factor Completely Randomized Design (CRD), namely the addition of roselle calyx powder (*Hibiscus sabdariffa* L.) at three different concentration levels. The research was conducted at the Food Processing Laboratory of the Culinary Arts Study Program.

Sensory evaluation was conducted using a hedonic test to measure panelists' preference for the Florentine bar cookie products. The test involved 25 semi-trained panelists (Gunawan et al., 2024). The panel consisted of lecturers and students from the Culinary Arts Study Program who had received training in sensory evaluation. The sensory parameters evaluated included taste, aroma, texture, and color. A five-point hedonic scale was used with the following criteria: 1 = strongly dislike; 2 = dislike; 3 = slightly like; 4 = like; 5 = strongly like (Gunawan et al., 2024). Product samples were presented randomly using three-digit codes at room temperature. Panelists were asked to taste the samples and record their evaluations on the

provided questionnaire sheets. Mineral water was provided to neutralize the palate between sample evaluations.

Nutritional content analysis was conducted on the Florentine bar cookie sample that received the highest score in the sensory evaluation. The nutritional analysis was carried out at the Laboratorium Badan Standarisasi dan Kebijakan Jasa Industri, Balai Besar Standarisasi dan Pelayanan Jasa Industri Semarang. The analysis was performed using a minimum of two replications for each sample. The nutritional parameters analyzed included moisture content (%) using the gravimetric method (SNI 01-2891-1992), ash content (%) using the gravimetric method (SNI 01-2891-1992), protein content (%) using the Kjeldahl method (SNI 01-2891-1992), fat content (%) using the Soxhlet method (SNI 01-2891-1992), carbohydrate content (%) using the by-difference method, crude fiber content (%) using the gravimetric method (SNI 01-2891-1992), and energy value (kcal/100 g) calculated using the Atwater method. Each parameter was analyzed in duplicate to ensure accuracy and precision of the results. The nutritional analysis results were then compared with the Indonesian National Standard (SNI) for similar products and the recommended Indonesian Recommended Dietary Allowance (RDA).

Hedonic test data were analyzed using the non-parametric Kruskal–Wallis test at a 95% confidence level ($\alpha = 0.05$) to determine whether there were significant differences among treatments. If the Kruskal Wallis test indicated significant differences, a Mann–Whitney test was conducted as a post hoc analysis to identify which treatments differed significantly. Data analysis was performed using IBM SPSS Statistics version 28.0 for MacOS.

Results and discussion

Sensory test result

Sensory evaluation was conducted to determine consumer acceptance of Florentine bar cookies with the addition of roselle calyx powder at three different concentration levels. The treatments tested included R1 (1.64% w/w), R2 (4.10% w/w), and R3 (6.56% w/w). The evaluation was carried out using a hedonic test involving 25 semi-trained panelists. The use of semi-trained panelists provides greater discriminative ability in detecting differences between samples compared to untrained panelists, thereby yielding more consistent and reliable assessments in the sensory evaluation of functional food products, particularly for products with relatively minor formulation modifications (Rodriguez, 2022). This panel composition is consistent with methodological approaches adopted in comparable studies of El-Sayed et al. (2020), Alya et al., (2025), Abdurrahim et al. (2025), and S & M, (2025), each employed 20 to 25 semi-trained panelists in their respective sensory evaluations, further affirming the methodological appropriateness of the panel size applied in the present study.

The results of the hedonic test analysis for taste, aroma, texture, and color of the Florentine bar cookies are presented in Table 2. The Florentine bar cookie products from each treatment are shown in Figure 2 (R1), Figure 3 (R2), and Figure 4 (R3).

Table 2. Mean hedonic scores of Florentine bar cookies

Sensory attribute	Mean score			P-value
	R1	R2	R3	
Taste	4.48 ± 0.81 ^a	3.96 ± 0.77 ^a	3.28 ± 0.83 ^c	0.000*
Aroma	4.00 ± 0.80 ^a	3.64 ± 0.69 ^a	3.60 ± 0.80 ^a	0.158
Texture	4.04 ± 0.82 ^a	3.32 ± 0.79 ^b	3.32 ± 0.93 ^b	0.005*
Color	4.04 ± 0.77 ^a	3.80 ± 0.69 ^a	3.56 ± 1.13 ^a	0.241

Notes: Values followed by different superscript letters within the same row indicate significant differences based on the Mann–Whitney test ($p < 0.05$). Data are presented as mean ± standard deviation. *Significance level set at $\alpha = 0.05$.*



Figure 2. Florentine bar cookies with the addition of 1.64% w/w roselle powder (R1)



Figure 3. Florentine bar cookies with the addition of 4.10% w/w roselle powder (R2)



Figure 4. Florentine bar cookies with the addition of 6.56% w/w roselle powder (R3)

The results of the Kruskal–Wallis test at a 95% confidence level showed that the addition of roselle powder produced different effects on each sensory parameter evaluated. The addition of roselle powder had a significant effect on taste ($p < 0.05$) and texture ($p < 0.05$). In contrast, roselle powder addition did not show a significant effect on aroma ($p > 0.05$) or color ($p > 0.05$). These results indicate that variations in roselle powder concentration exert a greater influence on the product's physical characteristics and flavor than on its visual and aromatic attributes.

A Mann–Whitney post hoc test was conducted to identify which treatments differed significantly. For the taste attribute, the results showed that all three formulations differed significantly from one another. The order of panelists' preference for taste was $R1 > R2 > R3$, indicating that higher concentrations of roselle powder were associated with lower taste acceptability. This decline in preference is likely due to the increasing intensity of sourness as the concentration of roselle powder increased. For the texture attribute, treatment R1 differed significantly from R2 and R3 ($p < 0.05$), whereas no significant difference was observed between R2 and R3 ($p > 0.05$). This suggests that the addition of roselle powder at a concentration of 4.10% w/w was sufficient to produce a textural change detectable by panelists, while increasing the concentration from 4.10% w/w to 6.56% w/w did not result in a substantial additional change in texture.

Taste preference scores showed a clear decreasing trend with increasing roselle powder concentration ($R1: 4.48 > R2: 3.96 > R3: 3.28$). The reduction in taste acceptability at higher concentrations indicates the

presence of a consumer tolerance threshold for functional flavor intensity in Florentine bar cookies. A similar phenomenon was reported by Shatat et al. (2023) in cookies fortified with vegetable extracts, and by Kuchtová et al. (2018) in cookies fortified with antioxidant-rich fruits, where increasing concentrations of bioactive ingredients consistently reduced hedonic taste scores.

The decrease in taste preference observed in formulation R3 can be explained by the high content of bioactive compounds, particularly anthocyanins and organic acids. According to Mahmoud et al. (2022), organic acids in roselle flowers, including citric, malic, and tartaric acids, contribute significantly to the characteristic sour taste. At high concentrations, the accumulation of organic acids and anthocyanins can produce an astringent taste that is less acceptable to consumers. Anthocyanins and other polyphenolic compounds are astringent substances that generate an astringency sensation, especially at concentrations exceeding the consumer perception threshold (Osakabe et al., 2024). The interaction between roselle polyphenolic compounds and proteins and carbohydrates in the dough matrix may also result in a bitter aftertaste in the cookies product.

The absence of a significant difference in the aroma attribute ($p > 0.05$) indicates that the characteristic aroma of roselle did not dominate the sensory profile of the cookies. This may be attributed to the degradation of volatile compounds during baking at high temperatures (150°C). Aroma components in tropical fruits such as roselle are thermolabile and prone to volatilization or thermal degradation during baking. According to Zia et al. (2024), thermal processing at temperatures above 140°C can cause a loss of up to 40–60% of volatile compounds responsible for characteristic aromas in fruit-based products. Cheng et al. (2023) reported that aroma compound degradation in fruits is strongly influenced by heating temperature, with a reduction in d-limonene concentration of up to 70.51% in fruit juice subjected to thermal pasteurization. In addition, the dominant aroma of other ingredients such as roasted nuts (sunflower seeds, pumpkin seeds, cashew nuts, and almonds) likely masked the relatively weak roselle aroma after baking. Valdés García et al. (2021), explained that roasted nuts generate highly potent volatile compounds, particularly pyrazines and aldehydes, which can dominate the aroma profile of composite products and obscure weaker aromatic components.

The significant effect of roselle powder on the texture of Florentine bar cookies can be linked to its fiber and pectin content, which influence the structure of the dough matrix. Formulation R1 achieved the highest texture score (4.04), indicating that the addition of 1.64% w/w roselle powder produced the most preferred texture. Pectin in roselle powder functions as a binding agent that can improve product structure through the formation of a gel network, increasing dough cohesiveness. Yuliarti et al. (2024) reported that the addition of low-methoxyl pectin at low concentrations (0.5–1.5%) can form a gel network that strengthens the overall structure of cookies by enhancing the viscoelastic properties of the dough, resulting in a more compact yet still crispy texture. However, at higher concentrations (R2 and R3), excessive pectin content may cause a harder and less crispy texture due to competition for water absorption between pectin and flour components. Liu et al. (2019), explained that at high pectin concentrations (>6%), there is a significant increase in water absorption and difficulty in gluten network formation due to competition for water between gluten and dietary fiber particles. An optimal balance between moisture, chewiness, and crispness was achieved in formulation R1, aligning with consumer preferences for snack bar products that are not overly hard while still maintaining desirable crispness.

The color attribute did not show significant differences among formulations ($p > 0.05$), although a visual gradation in red color intensity was observed. This may be due to anthocyanin degradation during baking and changes in dough pH that affect pigment stability. Anthocyanins are pigment compounds that are sensitive to temperature and pH, making them susceptible to degradation under baking conditions. Xue et al. (2024), in a comprehensive review, explained that anthocyanins have low stability and are highly vulnerable to environmental factors such as high temperatures (>150°C) and pH, leading to pigment degradation of up to 50–70% during thermal processing in bakery products. Chua et al. (2024), confirmed

that anthocyanins are highly sensitive to pH changes, with the highest stability under strongly acidic conditions ($\text{pH} < 3$), and undergo significant color degradation through a two-stage mechanism affecting color intensity and brightness. Anthocyanin degradation occurs through glycosidic hydrolysis and opening of the pyrylium ring, producing colorless chalcone compounds. Despite pigment degradation, semi-trained panelists were still able to appreciate the resulting color gradation, indicating that the color changes were not substantial enough to affect overall hedonic evaluation.

Based on the sensory evaluation of Florentine bar cookies with the addition of roselle powder at three different concentrations of R1 (1.64% w/w), R2 (4.10% w/w), and R3 (6.56% w/w), it can be concluded that roselle powder addition significantly affected taste and texture, but had no significant effect on aroma and color. Formulation R1 with the addition of 1.64% w/w roselle powder showed the best acceptance, achieving the highest scores across all sensory parameters (taste: 4.48; aroma: 4.00; texture: 4.04; color: 4.04), indicating that a low concentration of roselle powder provides an optimal balance between functional value and consumer acceptability.

Increasing roselle powder concentration tended to reduce panelists' preference levels, particularly for taste, which showed a significant decline due to the increased intensity of sour and astringent flavors from high anthocyanin and organic acid content. Therefore, formulation R1 with the addition of 1.64% w/w roselle powder represents the optimal concentration that can deliver functional benefits without compromising the sensory quality of Florentine bar cookies.

Nutritional content of Florentine bar cookies

Evaluation of the nutritional content of food products is a crucial aspect in determining their nutritional value and contribution to meeting consumers' daily nutrient requirements. Proximate analysis, including parameters such as energy, protein, fat, carbohydrates, crude fiber, moisture content, and ash content, provides comprehensive information on the nutrient profile of a food product. Nutritional content measurement was conducted using the standard SNI 01-2891-1992 methods in an accredited laboratory to ensure data accuracy and validity. The analysis was performed using a minimum of two replications for each sample.

The results of the nutritional analysis of Florentine bar cookies are presented in Table 2. The Florentine bar cookies produced in this study had a unit weight of 26 g, with a production yield of 10 bar cookies per recipe. This nutritional characterization is important for evaluating the feasibility of the product as an alternative functional snack bar capable of contributing to consumers' nutritional intake. The percentage of Recommended Dietary Allowance (RDA) was calculated based on the Reference Daily Intake (RDI) for the general population as stipulated in the Regulation of the Head of the Indonesian Food and Drug Authority Number 9 of 2026 concerning Nutrition Label References.

Table 2. Nutritional Composition of Florentine Bar Cookies

Nutrient	Per 100 g	Per Serving	RDA (General Population)	Percentage of RDA per Serving
Energy	510 Kcal	132.6 Kkal	2150 Kkal	6 %
Protein	10.36 %	2.69 g	60g	4 %
Fat	28.02 %	7.29 g	67 g	11 %
Carbohydrate	53.35 %	13.87 g	325g	4 %
Crude fiber	0,324 %	0.08 g	-	-
Ash content	1,698 %	0.44 g	-	-
Moisture content	6,568 %	1.71g	-	-

Notes: Each analysis was conducted in two replications per sample.

Based on the calculations, one serving of Florentine bar cookies (26 g) contributes 6% of the RDA for total energy (132.6 kcal out of 2150 kcal), 11% of the RDA for total fat (7.29 g out of 67 g), 4% of the RDA for protein (2.69 g out of 60 g), and 4% of the RDA for total carbohydrates (13.87 g out of 325 g). This per-

serving nutritional information is important to provide transparency for consumers regarding the product's contribution to daily nutritional requirements (Indonesian Food and Drug Authority, 2016).

The energy content of Florentine bar cookies, amounting to 132.6 kcal per serving (26 g) and contributing 6% of daily energy needs, results from the high energy density of the main ingredients, namely Florentine flour, nuts, and seeds. Although the energy content per serving is moderate compared with many commercial snack bars that provide 200–300 kcal per serving, Florentine bar cookies still fall into the category of energy-dense foods. Therefore, consumption should be managed carefully in the context of portion control, especially for consumers following weight management programs, but the product is well suited as a rapid energy source for physical activity or high energy demands.

The relatively high fat content of Florentine bar cookies, reaching 7.29 g per serving and contributing 11% of the RDA for fat, is attributable to the use of fat-rich ingredients in the formulation, particularly nuts and seeds. Cashew nuts (*Anacardium occidentale*) and almonds (*Prunus dulcis*) contain fats dominated by monounsaturated fatty acids (MUFA), such as oleic acid, and polyunsaturated fatty acids (PUFA), such as linoleic acid (Gonçalves et al., 2023). Sunflower seeds (*Helianthus annuus*) and pumpkin seeds (*Cucurbita spp.*) also contribute substantially, with lipid profiles rich in linoleic acid (omega-6) and tocopherols as natural antioxidants (Safitri et al., 2025). In addition, sesame seeds (*Sesamum indicum*) add further complexity to the lipid profile, with fats dominated by oleic and linoleic acids and the presence of lignans such as sesamol, which exhibit antioxidant activity (Oboulbiga et al., 2023). The combination of these five types of nuts and seeds in the Florentine bar cookies formulation results in a high fat density with a favorable fatty acid composition, allowing the product to serve as a nutrient-dense energy source with a healthier lipid profile compared to conventional snack bars that rely on saturated fats from butter or margarine (Vivar-Quintana et al., 2023).

The protein content of Florentine bar cookies is 2.69 g per serving (26 g), contributing 4% of the RDA for protein, and derives from the combined use of nuts and seeds in the formulation. Dodevska et al. (2022), reported that almonds, cashew nuts, and sunflower seeds provide protein with a relatively complete essential amino acid profile. The protein content of Florentine bar cookies is moderate relative to total serving weight because the proportion of nuts and seeds was limited to maintain balanced texture and sensory characteristics, while other ingredients such as flour, dried fruits (raisins and cranberries), and sesame seeds contribute less to total protein (George et al., 2022).

The carbohydrate content of Florentine bar cookies is 13.87 g per serving (26 g), contributing 4% of the RDA for carbohydrates, and mainly originates from dried fruits, particularly raisins and dried cranberries. Alasalvar et al. (2023), reported that dried fruits such as raisins and cranberries contain concentrated natural sugars due to the dehydration process. The relatively low carbohydrate content per serving is explained by the formulation, which is dominated by low-carbohydrate nuts and seeds, while dried fruits are used in limited amounts to provide natural sweetness and enhance palatability, in contrast to many commercial snack bars that rely heavily on dried fruits as primary ingredients (Shah et al., 2022).

The crude fiber content of Florentine bar cookies with roselle powder addition was relatively low, recorded at 0.08 g per serving or 0.31% of product weight. This finding, however, must be interpreted within the constraints of the analytical method employed, namely the SNI 01-2891-1992 gravimetric method. This method operates through successive acid and alkaline hydrolysis treatments, retaining only acid and alkali-insoluble residues comprising cellulose and lignin, while soluble dietary fiber, a proportion of insoluble dietary fiber, hemicellulose, and pectin fractions remain largely undetected (Yang et al., 2017). Consequently, the crude fiber value obtained represents only a subset of the actual total dietary fiber present in the product. This limitation is methodological in nature and should not be interpreted as indicative of fiber-poor raw materials, given that the ingredients used in this formulation are well recognized as sources of considerable dietary fiber content. To obtain a more accurate and comprehensive

characterization of the fiber fraction, future studies are recommended to employ enzymatic-gravimetric total dietary fiber methods, such as AOAC 985.29 or AOAC 991.43.

The moisture content of Florentine bar cookies, measured at 1.71 g per serving, reflects the characteristics of a baked dry cookie product that has undergone optimal baking. Low moisture content is essential for maintaining product stability, preventing microbial growth, and preserving the desired crisp texture. Products with moisture content below 10% generally exhibit good shelf stability and texture retention (Ardian et al., 2022).

The ash content of 0.44 g indicates the total mineral content of the product. This relatively low ash value suggests that the product does not contain minerals in high amounts, which is typical for baked cookie products. Ash content represents the total mineral residue remaining after complete combustion of organic matter (Fitrasyah et al., 2022).

Based on its nutritional composition, Florentine bar cookies can be classified as an energy-dense food product suitable for consumption as a snack or a rapid energy source. The energy density of this product is consistent with that of other functional snack bars reported in the literature. Barakat et al. (2025), demonstrated that high-energy nutritional bars formulated with natural ingredients delivered balanced macronutrients and bioactive compounds, positioning such products as health-promoting functional snacks particularly suited to athletes, shift workers, and individuals with heightened energy requirements. Similarly, Alfheeaaid et al. (2023), reported that innovative fruit and date-based bars with comparable energy profiles were well-suited as convenient energy-dense snacks for health-conscious populations.

In the context of these findings, consumption of Florentine bar cookies is recommended to be limited to a maximum of one serving per day for moderately active adults, in accordance with total daily energy balance considerations. Higher consumption may be appropriate for individuals with elevated energy demands, such as athletes or heavy manual workers, as energy-dense snack bars have been documented to effectively support performance and recovery in such populations (Jovanov et al., 2021). For children and adolescents, whose energy requirements differ substantially from those of adults, snack consumption (including energy-dense products) should be calibrated against total dietary intake to avoid exceeding recommended energy thresholds, given that high energy density snack foods have been associated with elevated total energy intake in this population group (Tripicchio et al., 2023).

Conclusion

The Kruskal–Wallis test results showed that the addition of roselle powder had a significant effect on taste ($p < 0.05$) and texture ($p < 0.05$), but no significant effect on aroma ($p > 0.05$) and color ($p > 0.05$). Formulation R1 achieved the highest acceptance, with taste score 4.48 ± 0.81 , aroma score 4.00 ± 0.80 , texture score 4.04 ± 0.82 , and color score 4.04 ± 0.77 . Nutritional analysis indicated that Florentine bar cookies per serving (26 g) provide 132.6 kcal of energy (6% RDA), 7.29 g of fat (11% RDA), 2.69 g of protein (4% RDA), and 13.87 g of carbohydrates (4% RDA). Formulation R1 represents the optimal concentration, producing a product with the best balance between functional value and sensory acceptability, and therefore holds potential to be developed as an innovative bakery product based on local ingredients.

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